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(71) Applicant: **SEIKO INSTRUMENTS INC.**
Chiba-shi, Chiba 261 (JP)

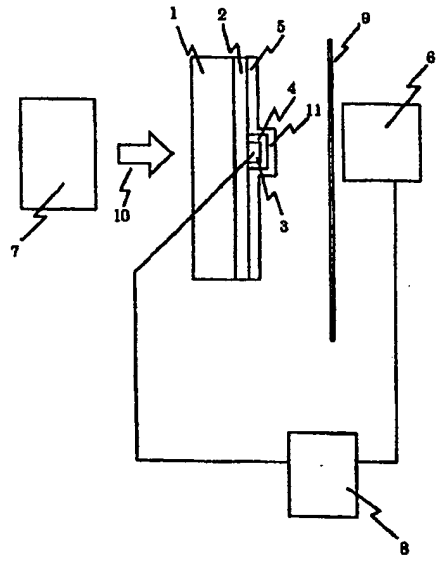
(72) Inventors:
- **Iwaki, Tadao**
  Mihama-ku, Chiba-shi, Chiba (JP)
- **Sato, Tatsuru**
  Mihama-ku, Chiba-shi, Chiba (JP)
- **Kawawada, Naoki**
  Mihama-ku, Chiba-shi, Chiba (JP)
- **Kawaguchi, Kouji**
  Mihama-ku, Chiba-shi, Chiba (JP)
- **Oohama, Satoshi**
  Mihama-ku, Chiba-shi, Chiba (JP)
- **Kuwahara, Seiji**
  Mihama-ku, Chiba-shi, Chiba (JP)
- **Okano, Hiroshi**
  Mihama-ku, Chiba-shi, Chiba (JP)

(74) Representative: **Sturt, Clifford Mark et al**
Miller Sturt Kenyon
9 John Street
London WC1N 2ES (GB)

(54) Record head

(57) A record head having a photoconductive layer (2) formed on a substrate (1), a source electrode (3) formed on the photoconductive layer (2), means for supplying ink onto the photoconductor (2) and an opposed electrode (6). The means for supplying ink and the opposed electrode (6) are arranged with a gap sufficient for incorporating record paper (9). A power source (8) applies voltage between the source electrode (3) and the opposed electrode (6) and light irradiating means (7) supplies light in correspondence with the desired picture pixel to the photoconductor.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

The present invention relates to a record head used in a record device for providing output picture on record media capable of dealing with a wide variety of needs of industries ranging from the printing industry where high speed output of high quality picture is requested, the printer industry based on business or personal request to the electric appliance industry where general output devices and the like at low price using various kinds and uses of record media are requested.

According to an electrostatic acceleration type ink jet recording device in conventional ink jet printing (Tsutomu Uehara: "An electrostatic acceleration type ink jet recording device", Japanese Unexamined Patent Publication No. JP-A-2-72960), as shown by Fig. 10, in an ink record head 1001 having an ink injection port 1010 formed in a slit-like shape, an upper plate 1012 and a substrate 1011 forming the ink injection port 1010, a record electrode 1014 arranged on the substrate 1011 by a unit of a record pixel, an opposed electrode 1002 arranged opposedly to the ink injection port 1010, record paper 1005 moved along the opposed electrode 1002, a drive power source (HVP) for supplying high voltage to a selected electrode of the record electrode 1014 and a photoconductor 1016 provided between the record electrode 1014 and a ground electrode 1015, oily ink 1018 is filled to reach the ink injection port 1010 and a voltage pulse in correspondence with a picture pixel is applied between the record electrode 1014 and the opposed electrode 1002 by which the oily ink 1018 is injected and flown and adhered and permeated to the record paper 1005 whereby a desired output print or picture is provided.

Particularly, according to the conventional example shown here, by connecting the record electrode 1014 and the ground electrode 1015 via the photoconductor 1016, when light in correspondence with a picture pixel signal is irradiated to the photoconductor 1016, a voltage pulse in correspondence with a picture pixel can easily be generated between the record electrode 1014 and the opposed electrode 1002 without using a drive integrated circuit having high withstand voltage or the like. Further, according to the example, light in correspondence with a picture pixel can easily be provided by light signal irradiating means 1004 capable of condensing light from a draft 1019 by a self foc lens 1020. Further, according to the conventional example, at least the record electrode 1014 is naturally formed dividedly in correspondence with the record picture pixel.

According to such a conventional electrostatic acceleration type ink jet recording device (hereinafter, referred to as slit jet system), by replacing a nozzle used in ink jet recording by the ink injection port 1010 in a slender slit shape, th resolution is not restricted by th nozzle and further, cleaning of the ink injection port 1010 can be facilitated.

Furth r, according to the slit jet system, color output print can easily be provided by using a plurality of the ink injection ports 1010 and injecting the oily inks 1018 having different colors into the respective ink injection ports 1010.

The following problems are posed according to the conventional ink jet recording system.

(1) It is difficult to promote the resolution since nozzles are used for injecting ink.
(2) The ink jet recording system is classified into a continuous type and an on-demand type. According to the continuous type, although the record speed is high, the device is difficult to simplify due to recovery of unnecessary ink or the like whereas according to the on-demand type, although the constitution of the device is simplified, the record speed is difficult to accelerate.

The following problems are posed according to the slit jet system for resolving the above-described problems of the ink jet recording system.

(1) It is difficult to promote the resolution since ink is flown by arranging record electrodes in correspondence with the units of record pixels.
(2) It is difficult to optimize ink characteristic and control applied voltage and timing thereof since in applying voltage on the record electrodes, when a selected record electrode and a nonselected record electrode are contiguous to each other, discharge phenomenon is caused between the both electrodes.
(3) Deterioration of the record electrode is significant since the record electrode is brought into contact with ink and further, high voltage is applied thereon.

Hence, it is a problem of the present invention to provide a record head by which highly fine printing with high quality is carried out at high speed and where output printing without selecting the shape of a record medium can be carried out in a noncontact state.

SUMMARY OF THE INVENTION

In order to resolve the above-described problem, the record head of the present invention is provided with a constitution in which electric charge is supplied from a source electrode to ink by optically switching a photoconductor installed between a source electrode that is an electric charge supply source and ink and the ink supplied with the electric charge is separated and flown from a predetermined portion by an electrostatic force. Specific constitutions are shown below.

[Constitution 1] A record head in which electric

charge is applied to a predetermined ink portion by optically switching a photoconductor provided between a source electrode that is an electric charge supply source and ink and the ink portion supplied with the electric charge is separated and flown by an electrostatic force wherein at least the source electrode and a portion of supplying the electric charge to the ink are formed to separate from each other by a predetermined distance in a direction of a plane.

[Constitution 2] In the record head of Constitution 1, at least the source electrode and a portion of separating and flying the ink supplied with the electric charge are formed to separate from each other by a predetermined distance in an ink flying direction.

[Constitution 3] In the record head of Constitution 1 or 2, the record head comprises at least a substrate, the source electrode, the photoconductor, an ink supply path for supplying ink to an insulating film and onto the photoconductor, an ink chamber formed on the photoconductor, an opposed electrode arranged remotely from the ink chamber by a predetermined interval, a power source for applying voltage between the source electrode and the opposed electrode and light irradiating means for irradiating light in correspondence with a desired picture pixel to the photoconductor.

[Constitution 4] In the record head of Constitution 3, the ink chamber includes an ink flying portion formed with a gap separating the ink flying portion from the source electrode by a predetermined distance and an irradiated portion of light in correspondence with the picture pixel is included in at least a portion or a total of a predetermined interval provided between a boundary between the source electrode and the photoconductor and a boundary between the photoconductor and the ink chamber.

[Constitution 5] In the record head of Constitution 3 or 4, the substrate is a transparent substrate and the light irradiated from the light irradiating means is irradiated from a side of the transparent substrate.

[Constitution 6] In the record head of any one of Constitutions 1 through 5, a gap between the ink and the source electrode is protected by an insulating film.

[Constitution 7] In the record head of any one of Constitutions 2 through 6, a portion of the ink chamber is formed by a wall formed on the substrate or the photoconductor or the source electrode or the insulating film.

[Constitution 8] In the record head of any one of Constitutions 2 through 7, a ceiling plate having a slit hole formed in correspondence with the ink flying portion is installed to interpose the ink chamber between the ceiling plate and the photoconductor.

[Constitution 9] In the record head of any one of Constitutions 2 through 8, the source electrode is formed in a linear shap .

[Constitution 10] In the record head of any one of Constitutions 2 through 8, the sourc electrode is formed in a ladder-like shape.

[Constitution 11] In the record head of any one of Constitutions 2 through 8, the source electrode is formed in a comb-like shape.

[Constitution 12] In the record head of any one of Constitutions 2 through 8, the source electrode is formed in a meandering shape.

[Constitution 13] In the record head of any one of Constitutions 2 through 12, the photoconductor is formed dividedly.

The above-described problem has been resolved by the above-described constitutions.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an explanatory view schematically showing an example of a first constitution of a record head according to the present invention.

Fig. 2 is an explanatory view schematically showing an example of a second constitution of a record head according to the present invention.

Fig. 3 is an explanatory view schematically showing an example of a third constitution of a record head according to the present invention.

Fig. 4 is an explanatory view schematically showing an example of a fourth constitution of a record head according to the present invention.

Figs. 5A-5B illustrate explanatory views schematically showing an example of modes of a photoconductor, a source electrode and an insulating film according to the constitution of the record head of the present invention.

Fig. 5A shows a state where the photoconductor is formed only at a vicinity of the source electrode.

Fig. 5B shows a state where the photoconductor is formed only at the vicinity of the source electrode and dividedly.

Fig. 6A-6D illustrate explanatory views schematically showing one example of modes of a photoconductor, a source electrode and an insulating film according to the constitution of the record head of the present invention in which Fig. 6A shows an example having a constitution using a ladder-like electrode, Fig. 6B shows the ladder-like electrode used in Fig. 6A, Fig. 6C shows the photoconductor used in Fig. 6A and Fig. 6D shows the insulating film used in Fig. 6A.

Fig. 7A-7D illustrate explanatory views schematically showing several examples of source electrodes used in constituting the record head of the present invention in which Fig. 7A shows a comb-like electrode, Fig. 7B shows a meandering electrode, Fig. 7C shows a ladder-like electrode having float electrodes and Fig. 7D shows a state where the float electrodes and the ladder-like electrode are formed at different layers.

Fig. 8 is an xplanatory view schematically showing the basic mode of the record head according to the pr sent invention and operation of respective constituent portions.

Fig. 9 is an explanatory view supplementing Fig. 8.

Fig. 10 is an explanatory view schematically showing the constitution of an ink jet recording device of an electrostatic acceleration type according to conventional ink jet printing.

DETAILED DESCRIPTION OF THE INVENTION

Next, an explanation will be given of embodiments of the present invention in reference to Figs. 8 and 9. Fig. 8 is an explanatory view showing schematically the basic constitution and operation of respective constituent portions in the record head of the present invention. Further, Fig. 9 is an explanatory view extracted from Fig. 8 for indicating titles and portions of a portion of Fig. 8 where notations 3, 4, A and C are shown. Here, according to notations designated in Figs. 8 and 9, numeral 1 designates a substrate, numeral 2 designates a photoconductor, numeral 3 designates a source electrode, numeral 4 designates an insulating film, numeral 5 designates an ink chamber, numeral 6 designates an opposed electrode, numeral 7 designates light irradiating means, numeral 8 designates a drive power source, numeral 9 designates a record medium, numeral 10 designates writing light, numeral 11 designates an ink injection portion, numeral 12 designates a ceiling plate, numeral 13 designates a wall and numeral 14 designates an electric field.

First, an explanation will be given of the basic constitution of the record head according to the present invention.

According to the basic constitution of the record head of the present invention shown by Fig. 8, the photoconductor 2 is formed on the substrate 1 comprising glass, transparent plastic or the like. Further, the source electrode 3 (refer to Fig. 9) comprising a metal material of aluminum, chromium, gold or the like or a conductive film of a metal oxide of ITO (Indium-Tin-Oxide) or the like, a conductive high molecular material or the like, is formed on the photoconductor 2. In this case, the photoconductor 2 may naturally be formed after forming the source electrode 3 on the substrate 1. Next, the insulating film 4 (refer to Fig. 9) is formed on the source electrode 3 to completely cover end points thereof (portions A shown by Fig. 9). That is, the insulating film 4 insulates the source electrode 3 from the ink chamber 5. The material constituting the insulating film 4 can be constituted by using a high molecular material of an acrylic group resin, a polyimide group resin, a polyethylene group resin, a rubber group resin or the like, or an insulating material of silicon dioxide, silicon nitride or the like. Further, the ceiling plat 12 having a slit-lik opening that is h ld by the wall 13 is installed abov the insulating film 4. A region surrounded by the ceiling plate 12, the wall 13, the insulating film 4 and the photoconductor 2 constitute the ink chamb r 5. In this case, the opening having a slit-like shape that is formed at the ceiling plate 12, is disposed on a straight line c nnecting the source electrode 3 and the opposed electrode 6 and m niscus of ink in the ink chamber 5 formed at the opening portion constitute the ink injection portion 11. The ceiling plate 12 can be constituted by using a high molecular material such as an acrylic group resin, a polyimide resin, a polyethylene group resin or the like, an insulating material of a glass or ceramic or the like. Further, the ink chamber 5 is provided with a flow path supplying ink to the slit-like opening and ink is supplied to the ink chamber 5 via means for supplying ink from outside. As the photoconductor 2, a silicon group photosemiconductor such as hydrogenerated amorphous silicon (hereinafter, abbreviated as a-Si:H) formed by a plasma CVD process or a reactive sputtering process or the like, or a chalcogenide group photosemiconductor such as CdSe, CdTe or the like, or an organic photosemiconductor (hereinafter, abbreviated as OPC) can be used.

According to the record head of the present invention, the opposed electrode 6 is installed opposedly to the slit-like opening and the opposed electrode 6 and the source electrode 3 are electrically connected to the drive power source 8. In this case, by forming the slit-like opening, that is, the ink injection portion 11 on the straight line connecting the source electrode 3 and the opposed electrode 6, the electric field operating on the injected ink can be provided linearly, that is, efficiently. Further, according to the example shown by Fig. 8, the interval between the opposed electrode 6 and the ink injection portion 11 or the ceiling plate 12 is constituted by an air layer and by inserting the record medium between the air layer and the ink injection portion 11 or the ceiling plate 12, the ink injected to the record medium is adhered by which a dot pattern in correspondence with desired picture pixels is recorded.

Next, a simple explanation will be given of the operation of the record head according to the present invention. DC voltage of 1 through 5 kV is applied between the source electrode 3 and the opposed electrode 6 by the drive power source 8. In this case, the applied voltage is varied in accordance with the structure or dimensions of the record head or the physical property of the ink. At this moment, electric charge (electron in this case) supplied from the drive power source 8 is conducted through the source electrode 3 and reaches the end portions (portions A shown by Fig. 9). The source electrode 3 is covered by the insulating film comprising an acrylic high molecular substance or the like and therefore, the electric charge passes through the photoconductor 2 from the portions A, passes through the ink chamber 5 from vicinities of end portions (portions C shown by Fig. 9) of the insulating film 4 and accumulated at the ink injection portion 11. In this case, when ther is no irradiation of light from outside, the volume resistivity of the photoconductor 2 falls in a range of 10E9

through 10E11 Ωcm. Further, the air layer of 0.2 through 1 mm is present and the record medium of print paper or the like is inserted between the opposed electrode 6 and the ink injection portion 11 and therefore, the resistance value of the interval is significantly larger than resistance values of other constituent members. Therefore, almost all of DC voltage applied by the drive power source 8 is dividedly provided to the air layer. The magnitudes of the drive voltage dividedly provided to the photoconductor 2 and the ink chamber 5 differ depending on the film thickness of the photoconductor 2 or distances between the portions A and the portions C and differ also depending on the width or the height of the ink chamber 5. When the writing light 10 is irradiated to a portion B of the photoconductor 2 shown by Fig. 8 by using the light irradiating means 7, the volume resistivity of the irradiated portion is decreased by about 10E3 through 10E5 of the volume resistivity when the portion is not irradiated, as a result, the amount of electric charge injected to the ink chamber 5 by passing from the end portions of the source electrode 3 (portions A shown by Fig. 9) to the B region of the photoconductor 2 and the end portions of the insulating film 4 (portions C shown by Fig. 9), is increased. The injected electric charge is attracted along with the ink to the side of the opposed electrode 6 by the electric field 14 from the opposed electrode 6, as a result, the radius of curvature of the interface of the ink injection portion 11 is increased and the electric charge is concentrated on the interface of the ink injection portion 11 and receives large attractive force from the opposed electrode 6. The procedure is successively continued and the ink is elongated to the side of the opposed electrode and finally, the ink is separated from the interface of the injection portion 11 and flown toward the opposed electrode 6 and adhered and fixed to the surface of the record medium 9. The procedure is continuously caused when the electric charge sufficient for flying the ink is injected even after finishing the irradiation of the writing light from the light irradiating means 7.

In this way, by successively irradiating the writing light 10 in correspondence with the picture pixel with a beam diameter in correspondence with the diameter of a dot intended to be flown, the amount of ink in correspondence with the desired picture pixel can be flown and adhered and fixed to the record medium.

The feature of the record head according to the present invention resides in that the electric charge is injected from the photoconductor 2 directly to the ink chamber 5 as well as that the end points of the source electrode 3 that is the electric charge injecting source (portions A of Fig. 9) and the electric charge injecting portions (portions C of Fig. 9) are arranged remote from each other by predetermined distances in a direction of the film face of the photoconductor 2 and the source electrode 3, the ink injection portion 11 and the opposed electrode 6 are linearly arranged. When the electric charge injection portion of the source electrode 3 that is the electric charge injecting source and the photoconductor 2 are simply arranged to overlap each other, a structure where the ink chamber 5 and the source electrode 3 are separated by the photoconductor 2, is constituted and the movement of the electric charge is carried out in a direction orthogonal to the film face of the photoconductor. Meanwhile, DC voltage of 1 through 5 kV is applied between the source electrode 3 and the opposed electrode 6 as described above and therefore, high voltage of about 100 through 500 V is applied on the photoconductor 2. Accordingly, when the photoconductor 2 is constituted by, for example, a-Si:H, pertinent optical switching function is not provided unless the film thickness is about 20 μm or more. Thereby, a time period of fabricating a-Si:H as the photoconductor 2 is prolonged from several hours to ten and several hours, which gives rise to high price. Further, pin holes are liable to cause in the film of a thin film photoconductor of OPC or the like, which gives rise to lowering of yield. In the meantime, according to the present invention, the electric charge is injected from the photoconductor 2 directly to the ink chamber 5 and at the same time, the distances to the end points (vicinities of points C of Fig. 4) of the source electrode 3 that is the electric charge injecting source become substantially equivalent to the film thickness of the photoconductor 2.

For example, when a-Si:H is used as the photoconductor 2, by setting the distances between the electric charge injection points (portions A of Fig. 9) and the electric charge discharge points (portions C of Fig. 9) to 20 through 50 μm, an effect substantially the same as that when a-Si:H having the film thickness of 20 through 50 μm is formed, can be provided. Naturally, in this case, the irradiated writing light 10 is irradiated over an entire face from the electric charge injection points through the electric charge discharge points. Further, in this case, the magnitude of the drive voltage dividedly provided to the photoconductor 2 is dependent not only on the distances from the electric charge injection points to the electric charge discharge points but the film thickness of the photoconductor 2. That is, the thinner the film thickness of the photoconductor 2, the larger the film resistance and the switching operation of electric charge can be carried out over a range of voltage that is increased by that amount. Further, even when pin holes are caused in the photoconductor, no significant influence is naturally effected on the optical switching operation. Therefore, according to the record head of the present invention, the optical switching function can be easily provided by using the photoconductor having a thin film thickness and therefore, there is provided an advantage where the record head can be fabricated inexpensively and with high yield.

Further, the flying of ink is caused by concentrating the electric charge injected from the electric charge injection portions (portions C shown by Fig. 9) to inside of the ink, to the ink injection portion 11 by diffusion and electric field and attracting the ink injection portion 11 to

the opposed electrode 6 mainly by th operation of the electric fi ld. Therefore, by conc ntrating and effectively operating the electric field, the flying of ink can b facilitated and the energy can be decreased. As shown by Fig. 8, by installing th ink injection portion 11 at the location where the operation of the electric field generated by applying the voltage between the source electrode 3 and the opposed electrode 6 by the drive power source 8, is significant, that is, on the straight line, the stable flying of ink can be facilitated and the applied voltage can be reduced.

Next, an explanation will be given of the case where OPC is used as the photoconductor 2. In this case, caution is particularly required when OPC of a laminated layer type constituted by separating an electric charge generating layer and an electric charge transporting layer. In this case, explaining in reference to Fig. 8, it is preferable to form the electric charge generating layer only at a portion of the photoconductor 2 in contact with the source electrode 3. The same is applicable to the case where the source electrode 3 is formed on the side of the substrate. The reason is that generally, the conductivity of the electric charge generating layer of OPC is comparatively large even in the dark state and therefore, when the electric charge generating layer is formed over an entire face as far as the ink chamber 5, the layer must be formed with the distances between the electric charge injection points and the electric charge discharge points of more than 100 μm and therefore, practical writing light energy irradiation cannot be carried out.

Further, when $Bi_{12}SiO_{20}$ crystal (hereinafter, abbreviated as BSO crystal) or the like is used as the photoconductor 2, the above-described problem is not caused and the photoconductor per se can also be used for the substrate, however, the drive voltage for use becomes significantly higher and the material per se becomes expensive.

[Working Examples]

An explanation will be given of embodiments of the present invention in reference to the drawings as follows.

(Example 1)

Fig. 1 is an explanatory view showing one example of the first constitution of the record head according to the present invention.

Numeral 1 designates the substrate, numeral 2 designates the photoconductor, numeral 3 designates the source electrode, numeral 4 designates the insulating film, numeral 5 designates the ink chamber, numeral 6 designates the opposed electrode, numeral 7 designat s the light irradiating means, numeral 8 d signates the drive power source, numeral 9 designates the record medium, numeral 10 designates the writing light and numeral 11 designates the ink injection portion. In Fig. 1, a state wher high voltage is applied between the source electrode 3 and the opposed electrode 6 by using th drive power source 8 is produced and the writing light 10 is irradiated to the photoconductor 2 by using the light irradiating means 7 from the side of the source electrode 3. As a result, the resistance value of the irradiated region of the photoconductor 2 is lowered and photocurrent is flown in the region. Thereby, the source electrode 3 and the ink chamber 5 are brought into a conductive state, electric charge is injected into the ink chamber 5 and ink is flown from the ink injection portion 11 to the side of the opposed electrode 6 by receiving Coulomb's force and is adhered and fixed to the record medium 9.

According to the example, the photoconductor 2 and the insulating film 4 per se constituted on the source electrode 3 form the ink chamber 5 and ink is held by the surface tension. That is, ink is supplied from outside ink supplying means, not illustrated, transmitted through the ink chamber 5 by the surface tension and fills the ink chamber 5. Although not clearly represented in Fig. 1, the ink chamber 5 is linearly formed in a direction orthogonal to paper face. The structure is featured in that it is an extremely simple structure although the filling state of ink filled in the ink chamber 5 is changed by the attitude of holding the record head and the flying characteristic is influenced thereby.

The insulating film 4 is formed by a thick film of about 10 through 50 μm. According to the example, the film is fabricated by coating photoreactive acrylic group resin by a spin coating process, and thereafter, exposing and developing the film by using an exposure mask in correspondence with a predetermined shape pattern. Of course, other resin material may be printed for the insulating film 4, or an insulating material of silicon dioxide or silicon nitride or the like may be formed by a physical gas phase vapor deposition process of a vacuum deposition process or a sputtering process or the like and thereafter, the film may be fabricated in a predetermined shape by using a resist.

As the material of the photoconductor 2, a photoconductive single crystal material of Se group, CdS group, ZnO group, BSO ($Bi_{12}SiO_{20}$) or the like, an inorganic conductor of hydrogenerated amorphous silicon of i type, pi type, pin type or the like, or a lamination type organic photoconductor such as CTL/CGL or the like can be used. As the photoconductor 2, the photoconductivity is important and it is preferable that potential difference of surface potential caused by attenuation of light is large.

The dark resistance of the inorganic photoconductor or the organic photoconductor falls in a range of 10E11 through 10E14 Ω·cm and the resistance value is lowered to 10E8 through 10E11 Ω·cm by irradiating light to the photoconductor 2 by which photocurrent is flown in th irradiated region. Further, in respect of the film thickness of the photoconductor 2, 20 through 50 μm is

preferable and as electric properties, the resistance value at the dark place is large and high sensitivity and fast light response are required which can be satisfied by the above-described photoconductor.

Further, when amorphous silicon is used as the photoconductor 2, the dark resistance falls in a range of 10E9 through 10E11 Ω·cm and the resistance value can be lowered to 10E4 through 10E6 Ω·cm by irradiating light to the photoconductor 2 by which large surface potential difference can be ensured. Further, naturally, the thinner the film thickness of the photoconductor and the longer the distances from the electric charge injection portions to the electric charge discharge portions, the more increased is the dark resistance value. Although a-Si:H of 1 through 10 μm is used in this example, it is optimum to set the film thickness preferably to about 5 μm.

Further, in order to increase the dark resistance value as well as realize jumping of ink having high resolution by minimizing expansion of electric charge in the direction of film face, it is preferable to use hydrogenerated amorphous silicon of i type where impurity elements are removed.

A semiconductor laser can be used as the light irradiating means 7 according to the present invention and the writing light 10 is irradiated from the light irradiating means 7 to a position on the photoconductor 2 in correspondence with a desired picture pixel. On the photoconductor 2, the resistance value of only the irradiated desired picture pixel region is lowered. In this case. the photosensitivity can be promoted by promoting the light attenuation rate of the photoconductor 2 by matching the oscillation wavelength of the laser beam with the absorption coefficient of the photoconductor 2 in respect of the oscillation wavelength. Further, the light irradiating means 7 can optimize the irradiated light intensity, the focus light spot shape or the like by an optical lens or the like in respect of the light irradiated from a semiconductor laser or the like and can constitute also a light scanning mechanism constituted by a polygonal mirror or the like. According to the record head of the present invention, laser beam is irradiated from the light irradiating means 7 and therefore, picture can be formed on the photoconductor 2 at a position in correspondence with a desired picture pixel in a noncontact state and at high speed. Although according to the embodiment, a semiconductor laser is used as the light emitting source of the light irradiating means 7, the light source is not limited thereto but He-Ne laser, or a semiconductor laser array or an LED array or a halogen lamp or the like can be used sufficiently as a light emitting source. Further, a light shutter array or a liquid crystal television set may naturally be used in place of an optical scanning system.

According to the embodiment, electric charge is injected into ink by irradiating light onto the photoconductor 2 and the amount of injecting electric charge is determined by the spot diameter of th laser beam emitted by the light irradiating means 7, the intensity of the irradiated light and th pulse width of irradiation. The larger the laser spot diamet r, the larger the irradiated region of the photoconductor 2 and the more the injection amount. Furth r, by increasing the intensity of the irradiated light, the resistance value of the photoconductor 2 is further lowered, the photocurrent is more liable to flow and the amount of injection into the ink is also increased. This is applicable to the case where the irradiation pulse width is made variable. According to the record head of the present invention, by controlling the amount of electric charge injected into the ink, the ink jumping speed can be made high and variable in correspondence with the object of recording.

A metal thin film provided by a general thin film forming process can be used as a source electrode 3 of the present invention. According to the embodiment, an Al thin film having a thickness of 1 micron meter is used. Further, a conductive material may be used for the material of electrode and ITO (Indium-Tin Oxide) or ZnO or SnO_2 or compounds of these or a conductive high molecular material or the like can be used. However, in view of the constitution of the record head according to the present invention, although the record head functions when the resistance value of the source electrode 3 is smaller than the dark resistance of the photoconductor, a material having a resistance as low as possible is preferable to achieve stable operation.

A conductive material of aluminium, copper, gold or the like can be used for the opposed electrode 6 of the present invention.

The voltage value of the power source applied between the source electrode 3 and the opposed electrode 6 preferably ranges from 1kV to 4 kV. The value is varied depending on the conductivity, the viscosity or the surface tension of the ink filled in the ink chamber 5, the material used in the photoconductor 2, or the film thickness or the material of the insulating film 4. In respect of the polarity of the drive power source 8, although no influence is naturally effected in principle even if positiveness and negativeness are reversed, most of the ink is liable to be electrified by a negative pole and therefore, it is preferable to constitute a positive pole on the side of the opposed electrode 6.

As physical properties of ink according to the present invention, which particularly influence on jumping of ink, surface tension, viscosity and conductivity are pointed out. For example, when the conductivity and the viscosity are assumed to be constant, a maximum interval for ink to jump to the opposed electrode (hereinafter, referred to as maximum record interval) is increased in accordance with a reduction in the surface tension when the surface tension falls in a range of 20 through 50 dyn/cm. Accordingly, the smaller the surface tension, the smaller the resistant force in the process of injecting ink, ink can be injected even with a weak electric field and therefor , the maximum record interval can be increased. Generally, the surface tension is higher in th case of water ink, 72.8 dyn/cm (20 °C) for pure water

and the surface tension of an organic solvent ranges from 20 dyn/cm to 35 dyn/cm and therefor , ink formed by dissolving dyestuffs to an organic solvent is pref rably used as the ink used in the present invention. Further, the maximum record interval can be increased by reducing the surface tension by dissolving a surfactant of an anionic surfactant, a cationic surfactant, a nonionic surfactant or the like into the ink.

Although the viscosity of the ink solvent can be selected in a wide range, a solvent having a low viscosity is highly volatile and therefore, the preserving performance of ink is deteriorated and accordingly, a solvent having a boiling point in a range of 200 °C or higher is selected to ensure the preserving performance. In respect of the relationship between the viscosity and the maximum record interval, when the surface tension and the conductivity are assumed to be constant, the maximum record interval is increased with a reduction in the viscosity. Therefore, similar to the case of the surface tension, when the viscosity is low, the resistance force in the process of injecting ink is decreased and the maximum record interval can be increased.

For injecting ink, it is necessary to inject electric charge from the photoconductor 2 to ink and move electric charge to the ink injection portion 11. Therefore, the low conductivity is preferable, however, when the conductivity is excessively low, the electric charge is diffused into the ink before the electric charge injected to the ink reaches the front end of the meniscus of the ink formed at the ink injection portion 11 and therefore, the ink is not injected. Therefore, it is preferable to set the pertinent range of the conductivity of ink according to the present invention to 2×10E-9S/cm or lower.

Incidentally, in respect of the above-described set values of the ink characteristics, the optimum characteristic ranges of the surface tension, the viscosity, the conductivity and the like are not necessarily be limited to the above-described values since whether ink can be flown is dependent on conditions of light source of the light irradiating means 7, the voltage value applied between the source electrode 3 and the opposed electrode 6, a distance between a portion of injecting electric charge to the photoconductor 2 and a portion of discharging electric charge to the ink chamber 5, the film thickness of the photoconductor 2, the maximum distance between electrodes, the film thickness of the insulating film 4 and the like.

Further, by inserting the record medium 9 from paper feeding means omitted in the drawing to between the opposed electrode 6 and the ink injection portion 11, the flown ink is adhered and permeated to the record medium 9 and therefore, a desired print or picture is provided on the record medium 9. In this case, the dot size of the picture pixel transcribed on the record medium is determined by the distance between the record medium 9 and th record head, th v ltage value applied between the source electrode 3 and the opposed electrode 6 and the amount of the flown ink. The amount of the flown ink can be controlled by the amount of nergy of th writing light provided from the light irradiating means 7 to the photoconductor 2. That is, modulation of dot can be performed. In respect of the distance between the record medium 9 and th ink injection portion 11, when the distance is excessively short, the record medium may be brought into contact with the ink depending on the method of inserting the record medium 9 or wrinkle or the like of the record medium and when the distance is excessively long, the flown ink is fallen by the gravitational force and the picture pixel is difficult to form at a desired position. Accordingly, the distance between the record medium 9 and the ink injection portion 11 according to the example is preferably about 0.2 through 1 mm and about 0.5 mm as a desired distance.

As has been explained, by using the record head described in the example, print in correspondence with a picture pixel where modulation of dot can be performed becomes feasible.

(Example 2)

Fig. 2 is an explanatory view showing an example of the second constitution of a record head according to the present invention in which numeral 13 designates a wall. Incidentally, constituent elements in Fig. 2 having function the same as those in Fig. 1 are attached with the same numerals and an explanation thereof will be omitted.

The difference of the constitution of Fig. 2 from the constitution of Fig. 1 resides in that the ink chamber 5 is formed by the photoconductive film 2, the insulating film 4 and the wall 13 by installing the wall 13 on the photoconductive film 2. By such a constitution, the state of ink in the ink chamber 5 of the record head according to the present invention which has been indicated in Example 1, is less influenced by the attitude and the position of the record head.

Also in Fig. 2, similar to Example 1, a state where high voltage is applied between the source electrode 3 and the opposed electrode 6 by using the drive power source 8 is produced and the writing light 10 is irradiated from the side of the source electrode 3 to the photoconductor 2 by using the light irradiating means 7. At this moment, the resistance of the irradiated region of the photoconductor 2 is decreased, the source electrode 3 and the ink chamber 5 are brought into a conductive state, electric charge is injected into the ink chamber 5 and ink is flown from the ink injection portion 11 toward the side of the opposed electrode 6 and adhered and fixed to the record medium 9.

In this case, the direction of flying ink is controlled by using the wall 13, the injection amount and the speed of ink in respect of the distance between the ink chamber and the opposed electrode 6 are stabilized and further, by controlling the curv of the m niscus of ink, the efficiency of concentrating electric charg at the vicinity of the ink injection portion 11 can be promoted and the en-

ergy in respect of jumping of ink can be reduced.

Although the width of the ink chamber 5 is preferably wider with respect to introduction of ink, when the width is excessively large, the difference of significance in respect of the structure shown by Fig. 1 is lost. Further, the width is preferably narrower in order to efficiently concentrate electric charge of the ink injection portion 11. The width of the ink chamber 5 is preferably about 100 through 200 μm in the case of this structure although the width differs depending on ink and structure or material of the ink chamber.

Further, when the ink flows out from the wall 13, the ink is flown toward the side of the opposed electrode 6 and a desired picture pixel is difficult to continue. Therefore, in respect of the material of the wall 13 or the condition of the surface facing the opposed electrode 6, the angle of contact in respect of ink needs to be large and the insulating performance needs to be high. However, in respect of the angle of contact, the angle of contact relates to easiness in introducing ink into the ink chamber 5 and accordingly, a large angle may not simply be preferable. It is necessary to pertinently select ink for use (physical properties of viscosity, surface tension and the like), and the material and the surface condition of the wall.

As has been explained, by using the structure, the influence of the attitude and the position on the ink is reduced and at the same time, the ink flying direction or condition can be stabilized, and low energy formation and stabilization of the flying condition can be achieved by promoting the effect of concentrating electric charge to the ink injection portion 11. In this way, the structure shown by Fig. 2 can achieve the above-described effect by slight addition of structure to the structure of Fig. 1 and accordingly, it is a structure having high cost merit.

(Embodiment 3)

Fig. 3 is an explanatory view showing an example of the third constitution of a record head according to the present invention in which numeral 12 designates a ceiling plate. Further, constituent elements of Fig. 3 having functions the same as those in Figs. 1 and 2 are attached with the same numerals and an explanation thereof will be omitted.

The difference of the constitution of Fig. 3 from the constitution of Fig. 1 resides in that the ceiling plate 12 having a slit-like opening (hereinafter, referred to as slit) in correspondence with the ink injection portion 11 is arranged by being supported by the wall 13. By such a constitution, the state of ink in the ink chamber 5 of the record head of the present invention which has been indicated in Examples 1 and 2, is difficult to undergo influence by the attitude and the position of the record head and at the same time, the effect of concentrating electric charge to the ink injection portion 11 can significantly be promoted.

Also in Fig. 3, similar to the other examples, the state where high voltage is applied between the source electrode 3 and the opposed electrode 6 by using the drive power source 8 is produced and the writing light 10 is irradiated from the side of the source electrode to the photoconductor 2 by using the light irradiating means 7. At this moment, the resistance of the irradiated region of the photoconductor 2 is decreased, the source electrode 3 and the ink chamber 5 are brought into a conductive state, electric charge is injected into the ink chamber 5 and the ink is flown from the ink injection portion 11 toward the side of the opposed electrode 6 by receiving Coulomb's force and is adhered and fixed to the record medium 9.

The width of the slit provided at the ceiling plate 12 determines the maximum value of static pressure of ink at the ink injection portion 11 and the ink receiving the static pressure forms a semicircular projected face, that is, the meniscus at the ink injection portion 11 which determines the amount of supplying ink. Further, the smaller the slit width, the smaller the radius of curvature of the meniscus of ink can be constituted and the larger the Coulomb's force for injecting the ink can be constituted and therefore, the smaller the slit width, the more the record characteristic is promoted. Therefore, the width of the slit provided at the ceiling plate 12 is preferably about 50 through 100 μm which does not result a hazard in supplying the ink. Further, when ink flows out to the ceiling plate 12, the flowed-out ink is flown toward the side of the opposed electrode 6 and a desired picture pixel is difficult to continue. Therefore, as a material of the ceiling plate 12, a material having a large angle of contact in respect of ink used in the record head of the present invention and having excellent insulating performance needs to be used. Accordingly, in respect of the ceiling plate, the angle of contact is ensured by using polyimide resin, fluororesin or the like or processing the surface of the ceiling plate fabricated by an insulating material of glass, ceramic or the like by using a silane coupling agent or the like, and the above-described unstable phenomenon can be excluded when the static pressure of ink is pertinent. Furthermore, by using the ceiling plate 12, the direction of flying the ink can be controlled, the injection amount and the speed of the ink in respect of the distance between the ink injection portion 11 and the opposed electrode 6 are stabilized and further, the curve of the meniscus of ink is controlled by which the efficiency of concentrating ink can be promoted and energy required for flying ink can be reduced.

(Embodiment 4)

Fig. 4 is an explanatory view showing one example of the fourth constitution of a record head according to the present invention. Incidentally, in Fig. 4, constituent elements having function the same as those in Figs. 1, 2 and 3 are attached with the same numerals and an explanation thereof will be omitted.

Th differenc of the constitution of Fig. 4 from the constitution of Fig. 3 resides in the positional r lationship betwe n the photoconductor 2 and the source electrode 3 and the size of the photoconductor 2. In respect of the positional relationship, according to the constitution of Fig. 3 (similar to Figs. 1 and 2), the source electrode 3 is formed on the photoconductor 2 whereas according to the constitution of Fig. 4, the photoconductor 2 is formed on the source electrode 3. The record head of the present invention can be provided with such a constitution and the structure can be changed in accordance with compatibility or the like in the process of fabricating materials of the photoconductor 2 and the source electrode 3. That is, the degree of freedom of the fabrication process is excellent which is effective in promoting the productivity. Further, in respect of the size of the photoconductor 2, there is no necessity in view of function other than the region for achieving the optical switching function as the record head and therefore, the size can be saved. This is the structure necessary in using a material at high cost and is an important structure in view of restricting the function region and promoting the accuracy of flying position or the like.

Also in Fig. 4, the function is similar to those in the other examples and the state where high voltage is applied between the source electrode 3 and the opposed electrode 6 by using the drive power source 8 is produced and the writing light 10 is irradiated from the side of the source electrode 3 to the photoconductor 2 by using the light irradiating means 7. At this moment, the resistance of the irradiated region of the photoconductor 2 is decreased, the source electrode 3 and the ink chamber 5 are brought into a conductive state, electric charge is injected into the ink chamber 5 and the ink is flown from the ink injection portion 11 toward the side of the opposed electrode 6 by receiving Coulomb's force and is adhered and fixed to the record medium 9.

(Example 5)

Figs. 5A-5B illustrate explanatory views schematically showing one example of a photoconductor, a source electrode, and an insulating film according to the constitution of the record head of the present invention. Further, in Figs. 5A-5B, numeral 2 designates the photoconductor, numeral 3 designates the source electrode and numeral 4 designates the insulating film. Further, although in Figs. 5A and 5B, the photoconductor is formed limitedly only at the source electrode portion, that is, only the region functioned by the writing light, the present invention is not limited thereto.

Fig. 5A shows a state where the source electrode 3, the photoconductive film 2, the insulating film 4 or the photoconductive film 2, the source electrode 3 and the insulating film 4 are formed in this order on the substrate. According to the structure, since the photoconductive film 2 is f rmed all through the length, the region of discharging electric charge is extended through the entire fac of the end portions of the long side and in principle, th ink can be injected from all the regions. That is, in view of the constitution of the three members of the photoconductive film, the source electrode and the insulating film. the resolution may be consid red infinitive. This is one feature of the record head of the present invention.

Fig. 5B shows a state where the photoconductive film 2 is divided while the mode is similar to that of Fig. 5A. By such a structure, the region of discharging electric charge can be restricted. That is, this is effective in the case where the resolution is intended to be limited or the case where the region of discharging electric charge is intended to restrict in respect of the spot of the writing light.

In this way, the photoconductor 2 can be fabricated into various shape as in dividing it when there is no problem in view of function and it is necessary.

(Embodiment 6)

Figs. 6A-6D illustrate explanatory views schematically showing other example of a photoconductor, a source electrode and an insulating film according to the constitution of the record head of the present invention similar to Figs. 5A-5B.

Fig. 6A shows a total picture of the constitution. This shows one example of the constitution where a ladder-like electrode is used for the source electrode and as the constitution, a source electrode, a photoconductive film, an insulating film or a photoconductive film, a source electrode and an insulating film are formed in this order on a substrate. The explanation of these respective constituent portions is shown from Figs. 6B through 6D in which Fig. 6B shows the source electrode, Fig. 6C shows the photoconductive film and Fig. 6D shows the insulating film.

There are provided window portions where regions of discharging electric charge which are elements for restricting the ink flying portions of the record head are formed at the insulating film, which are formed in correspondence with the pitch of the ladder-like source electrode. For example, by such a constitution, an effect of prescribing the resolution and reducing interference among dots can be provided. In this way, the shape of the insulating film can be changed so far as there is no problem in view of function and it is necessary.

(Example 7)

Figs. 7A-7D illustrate explanatory views schematically showing several examples of source electrodes used in the constitution of the record head according to the present invention.

Fig. 7A shows a comb-like electrode, Fig. 7B shows a meandering electrode, Fig. 7C shows a ladder-like electrod having float electrodes and Fig. 7D shows a state where the float electrodes and the ladder-like elec-

trode are formed at different layers.

According to a source el ctrod , injection of electric charge is the most important function and when the function is satisfied, the basic problem, that is, the function of the record head is not prevented from being achieved whatever the shape is. The shape of the source electrode can be determined in accordance with the problem of the record head in respect of the shape, the purpose of promoting the record function (for example, controlling way of developing electric field or the like) and the like.

Further, although the float electrodes serve to promote the function of discharging electric charge, different from the function of the source electrode, the float electrode has been described since it constitutes one of application of the constitution.

(Example 8)

An explanation will be given of an example of color printing using the record head of the present invention.

Four of record heads each having a line shape in correspondence with the print width of a record medium are constituted to overlap vertically and inks of yellow (Y), magenta (M), cyan (C) and black (Bk) are supplied to the individual record heads from above.

As a procedure of recording, a state of applying high voltage between the individual source electrodes and the opposed electrode by a power source is produced and a yellow ink record head is disposed at a printing position. Next, the writing light is irradiated to a photoconductor of the yellow record head from the side of the source electrode by light irradiating means. At this moment, the resistance of an irradiated region of the photoconductor is decreased, the source electrode and an ink chamber are brought into a conductive state, electric charge is injected into the yellow ink chamber and yellow ink is flown from an ink injection portion toward the side of the opposed electrode by receiving Coulomb's force and is adhered and fixed to the record medium. Thereby, the yellow ink of desired picture pixels is provided at 1 line region of the record medium.

Next, the record head is moved and the magenta ink record head is disposed at the printing position. Further, the magenta ink of desired picture pixels is provided at 1 line region of the record medium by the above-described recording procedure.

Next, the record head is moved, the cyan ink record head is disposed at the printing position and printing operation similar to the above-described is carried out.

Finally, the record head is moved, a black ink record head is disposed at the printing position and printing operation similar to the above-described is carried out.

After carrying out printing of 1 line on the record medium through the above-described procedure, the record medium is moved by 1 line by paper feeding means and 4 of the record heads are moved back to home positions. By repeating the procedure, desired color picture pixels for each picture can b provided on th record medium.

Although according to the embodiment, 4 kinds of the inks are constituted, highly fine output print or picture of full color having no restriction in the print color is obtained by increasing the number of records heads and supplying inks of multiple colors.

Further, although according to the embodiment, an explanation has been given of a system of driving the record heads of the present invention at every time of transcribing the respective colors of YMCBk to the record medium, it is naturally possible to irradiate record pixel information of respective colors of YMCBk simultaneously onto a photoconductor by installing a structure simultaneously making access to the respective picture information of YMCBk in the light irradiating means. Incidentally, although according to the embodiment, an explanation has been given of the record head in a line shape, the record head of the present invention can be used in a serial shape and therefore, the total of device can also be made compact.

(Example 9)

An explanation will be given of an example of the fifth constitution using the record head of the present invention. According to the embodiment, multiple inks are injected by the record head.

For example, in the case of color printing as an object, according to the record head, a source electrode divided in 4, a photoconductor and an individually corresponding insulating film are formed on a substrate and ink chambers in correspondence with the respective divided source electrodes are provided. Further, inks of yellow (Y), magenta (M), cyan (C) and black (Bk) are supplied to the ink chambers.

As a recording procedure, a state where high voltage is applied between the individual source electrodes and the opposed electrode by the power source is produced and writing light is irradiated from the side of a source electrode of a yellow ink region to the photoconductor by light irradiating means. At this moment, the resistance of an irradiated region of the photoconductor is decreased, the source electrode and the ink chamber are brought into a conductive state, electric charge is injected into the yellow ink chamber and the yellow ink is flown from an ink injection portion toward the side of the opposed electrode by receiving Coulomb's force and is adhered and fixed to the record medium. Thereby, yellow ink of desired picture pixels is provided at 1 line region of the record medium.

Next, the record head is moved and a magenta ink record head is disposed at a printing position. Further, magenta ink of desired picture pixels is provided at 1 line region of the record medium by the above-described recording procedure.

Next, th record h ad is moved and a cyan ink record head is disposed at the printing position and

printing operation similar to the above-described is carried out.

Finally, the record head is moved and a black ink record head is disposed at the printing position and printing operation similar to the above-described is carried out.

After performing printing of 1 line on the record medium by the above-described procedure, the record medium is moved by 1 line by paper feeding means and the record heads are moved back to home positions. By repeating the procedure, desired color picture pixels for each picture can be provided on the record medium.

Although according to the example, 4 kinds of inks are constituted, highly fine output print or picture of full color is obtained by increasing a number of divisions of the record heads and supplying individually multiple colors of inks. Further, when a type of the record head of the present invention in use of a ceiling plate having a slit-like shape is used, 4 of slits are naturally formed at the ceiling plate.

Incidentally, although an explanation has been given of the record head in a line shape according to the example, the record head of the present invention can be used also in a serial shape and accordingly, the total of the device can also be made compact.

As has been explained, the examples of the present invention have been described.

Incidentally, in respect of the opening of the ceiling plate, even when the opening is formed by a round hole that is frequently used in the conventional ink jet printer, the operation of the record head having such a constitution can naturally be performed in a similar manner. By the example or by applying the example, various record heads of a 1 slit type, a multiple slit type, a slitless type, a 1 nozzle type, a multiple nozzle type and the like can be used.

As has been explained, a record head of the present invention may be provided with the following constitutions.

(1) At least a source electrode and a portion for supplying electric charge to ink are formed to separate from each other by a predetermined distance in a direction of a plane.

(2) At least a source electrode and a portion for separating and flying ink supplied with electric charge are formed to separate from each other by a predetermined distance in a direction of flying ink.

(3) Provided are at least a substrate, a source electrode, a photoconductor, an ink supply path for supplying ink to an insulating film and on the photoconductor, an ink chamber formed on the photoconductor, an opposed electrode, an air layer having a predetermined layer thickness between the opposed electrode and the ink chamber, a power source for applying voltage betwe n th source electrod and the opposed electrod and light irradiating means for irradiating light in correspondence with a desired picture pixel to the photoconductor.

(4) An ink chamber is provided with an ink flying portion formed with a gap from a source electrode by a predetermined distance and portions of ink irradiated with light in corr spondence with a pictur pix l includes at least portions or a total of a boundary between a source electrode and a photoconductor and a boundary between the photoconductor and the ink chamber.

(5) A substrate is constituted by a transparent substrate and is arranged such that light irradiated from light irradiating means is irradiated from the side of the transparent substrate.

(6) At least a gap between ink and a source electrode is protected by an insulating film.

(7) A portion of an ink chamber is formed by a wall installed on a substrate or a photoconductor or a source electrode or an insulating film.

(8) A ceiling plate having a slit hole formed in correspondence with an ink flying portion is installed to interpose an ink chamber between a photoconductor and the ceiling plate.

(9) A source electrode is formed-in a linear shape.

(10) A source electrode is formed in a ladder-like shape.

(11) A source electrode is formed in a comb-like shape.

(12) A source electrode is formed in a meandering shape.

(13) A photoconductor is formed to be divided.

Thereby, the following effects are achieved.

(1) Light is irradiated from the light irradiating means onto the photoconductor and therefore, the recording process is performed in a noncontact state and at high speed.

(2) The ink flying speed can be made high and variable in accordance with an object of the record medium by controlling the optical energy of the light irradiating means to thereby control the amount of electric charge injected into ink.

(3) Basically, nozzles for respective picture pixels are not needed in the record head and the high resolution is achieved and the cost is reduced and the cleaning after injecting ink can be facilitated by the slit constitution using the slit plate.

(4) The direction of flying ink is controlled by providing the slit at the ceiling plate, the amount of injecting ink and the flying speed in respect of the distance between the opposed electrodes are stabilized and further, by controlling the curve of the meniscus of ink, the efficiency of concentrating ink is promoted and the energy in respect of jumping of ink can be reduced.

(5) A plurality of record units can be used by constructing a constitution where record heads ov rlap each other v rtically and highly fine output print is

obtained in full color with no restriction of print colors.

(6) By constituting a record head in a line shape, a printable range can correspond to record paper, record speed is significantly shortened and high speed printing can be carried out.

(7) Highly fine output print in full color can be obtained by increasing a number of divisions of record heads and supplying individually multiple colors of inks.

(8) By constituting a record head in a serial shape, the record head can be constituted compactly.

(9) A device substantially similar to an on-demand type can be constituted since the amount of supplying ink can be controlled by a photoconductor with high speed performance of a continuance type.

(10) Compared with an ink jet system, the resolution can be restricted by a spot diameter of light supplying means and therefore, high resolution comparable to electronic photography can be achieved.

(11) Compared with an electronic photographing system, the constitution of device is simplified and the cost is reduced.

Expressions hereinabove based on the word "inject" may be understood to mean "eject" where the context so requires.

Claims

1. A record head in which electric charge is applied to eject ink by optically switching a photoconductor (2) associated with a source electrode (3) which acts as an electric charge supply source, characterised in that the source electrode (3) is electrically insulated from direct contact with the ink.

2. A record head as claimed in claim 1, wherein the photoconductor (2) is planar and the position or positions at which electric charge is imparted to the ink is or are separated from the source electrode (3) in the plane of the photoconductor (2).

3. A record head as claimed in claim 1 or claim 2, wherein the head has an ink ejection port (11) with the port (11) and source electrode (3) being spaced apart from each other in the ink ejection direction.

4. A record head as claimed in any preceding claim, further comprising a substrate (1), an electrically insulating film (4) formed on the source electrode (3), an ink supply path for supplying ink to an ink chamber (5) formed on and partly bounded by the photoconductor (2), an opposed electrode (6) arranged remotely from the ink chamber (5) by a predetermined interval, a power source (8) for applying voltage between the source electrode (3) and the opposed electrode (6) and light irradiating means (7) for irradiating light onto the photoconductor in correspondence with a desired picture pixel.

5. A record head as claimed in claim 4, wherein the area of the photoconductor (2) irradiated by the light irradiating means (7) is a portion of or all of the area of the photoconductor (2) exposed in the ink chamber (5).

6. A record head as claimed in claim 4 or claim 5, wherein the substrate (1) is a transparent substrate and the light irradiated from the light irradiating means (7) is irradiated through the transparent substrate (1).

7. A record hear as claimed in any of claims 4 to 6, wherein a boundary of the ink chamber (5) is formed by a wall (13) positioned on the substrate (1) or the photoconductor (2) or the source electrode (3) or the insulating film (4).

8. A record head as claimed in any of claims 4 to 7, wherein a boundary of the ink chamber (5) is formed by a ceiling plate (12) which has an aperture constituting the ink ejection port (11).

9. A record head as claimed in any preceding claim, wherein the source electrode is formed in a linear shape.

10. A record head as claimed in any of claims 1 to 8, wherein the source electrode (3) is formed in one of: a ladder-like shape, a comb-like shape, and a meandering shape.

11. A record head as claimed in any preceding claim, wherein the photoconductor (2) is formed dividedly.

FIG. 1

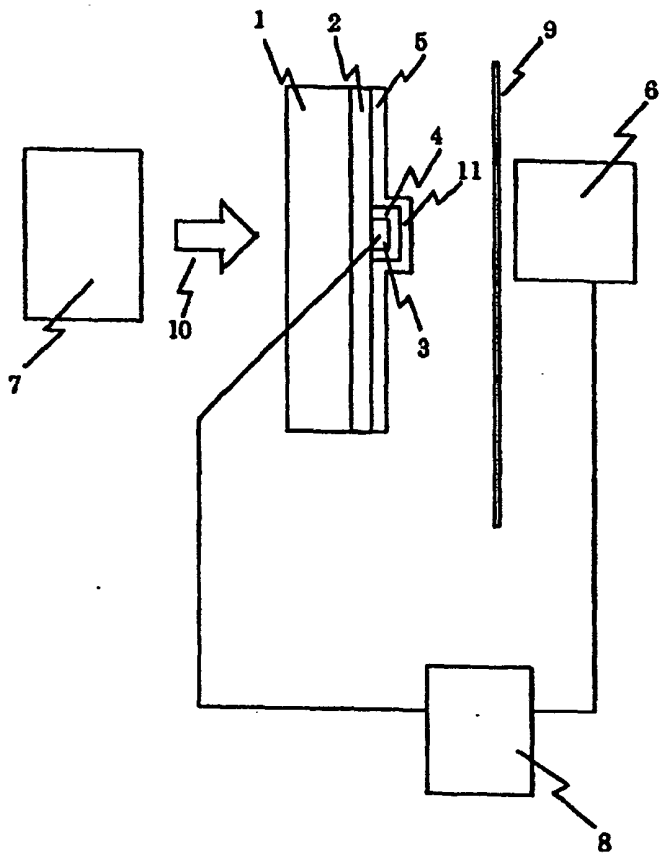


FIG. 2

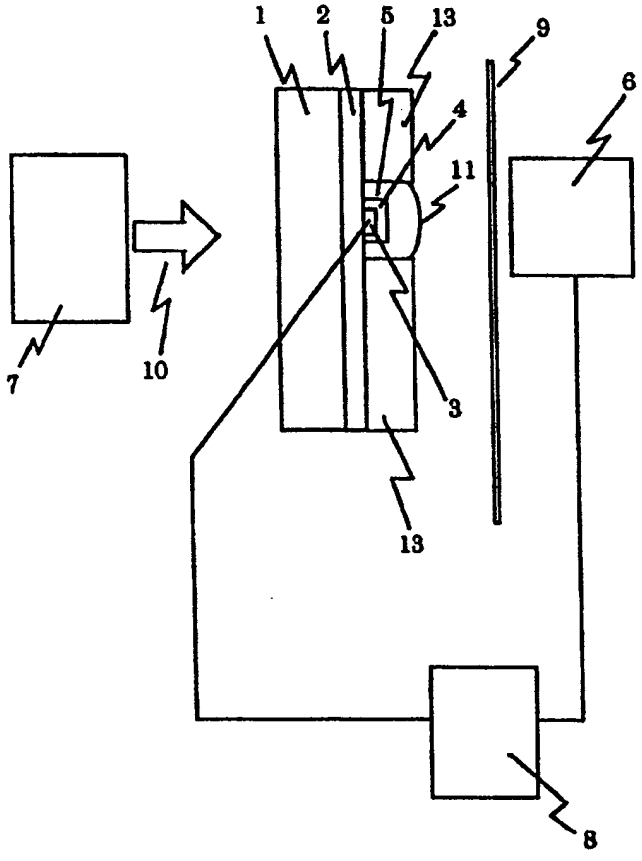


FIG. 3

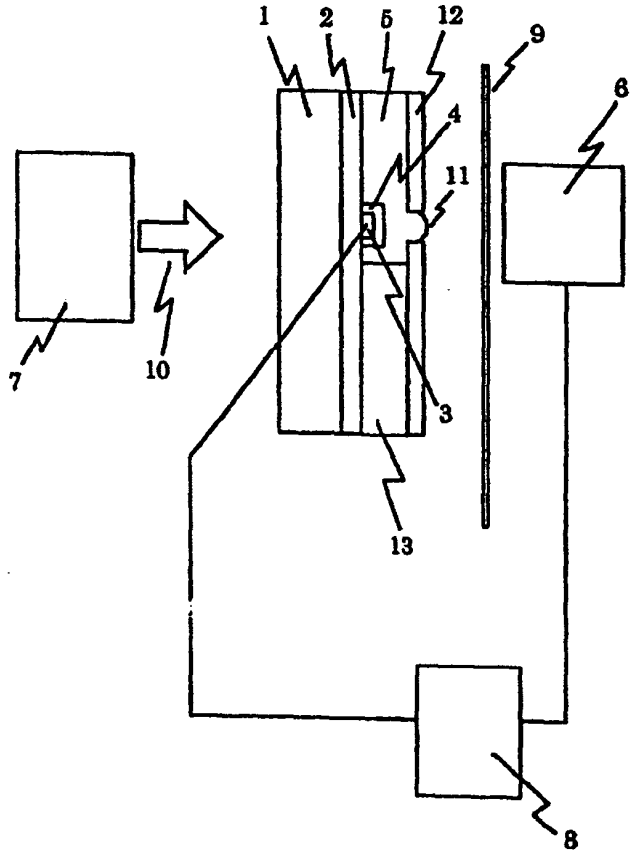


FIG. 4

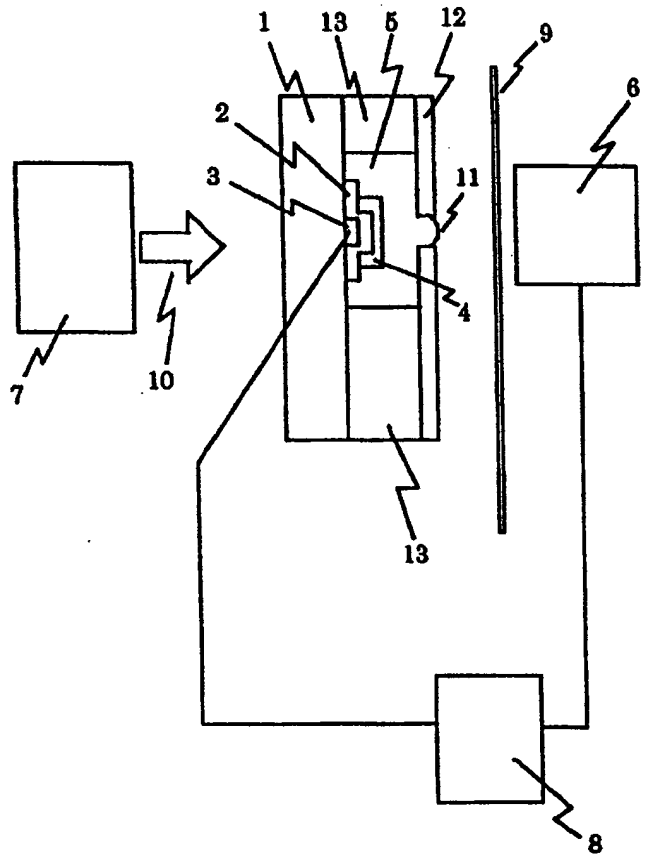


FIG. 5A

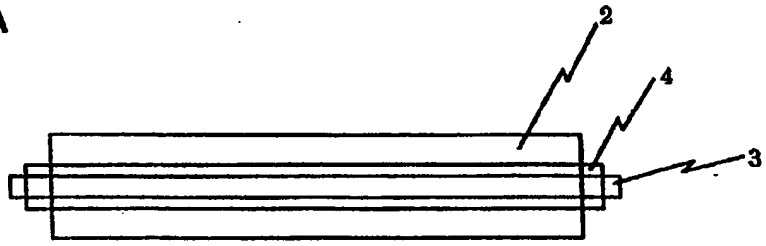


FIG. 5B

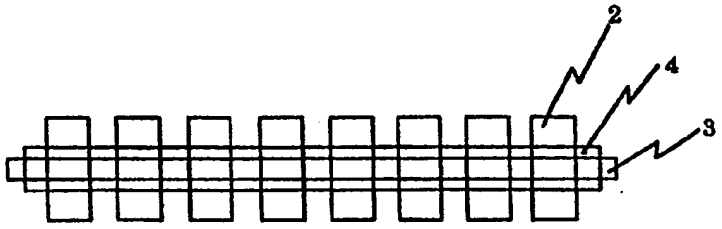


FIG. 6A

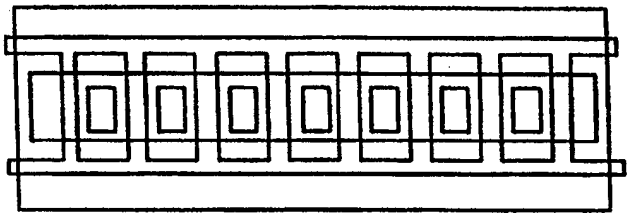


FIG. 6B

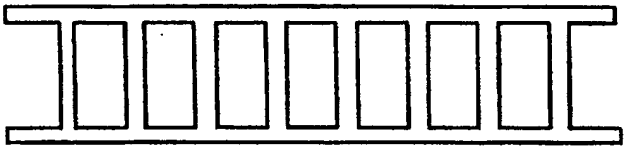


FIG. 6C

FIG. 6D

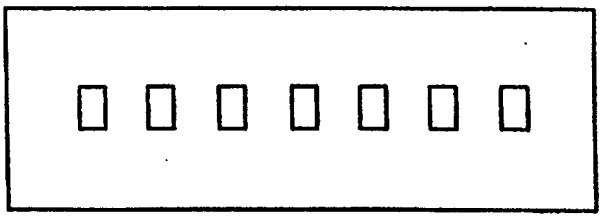


FIG. 7A 

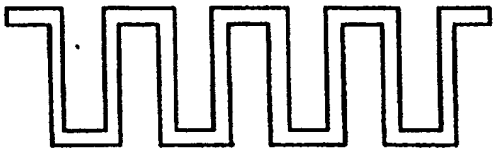
FIG. 7B 

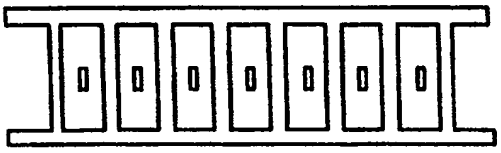
FIG. 7C 

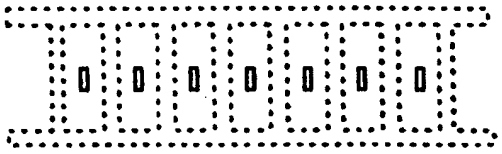
FIG. 7D 

FIG. 8

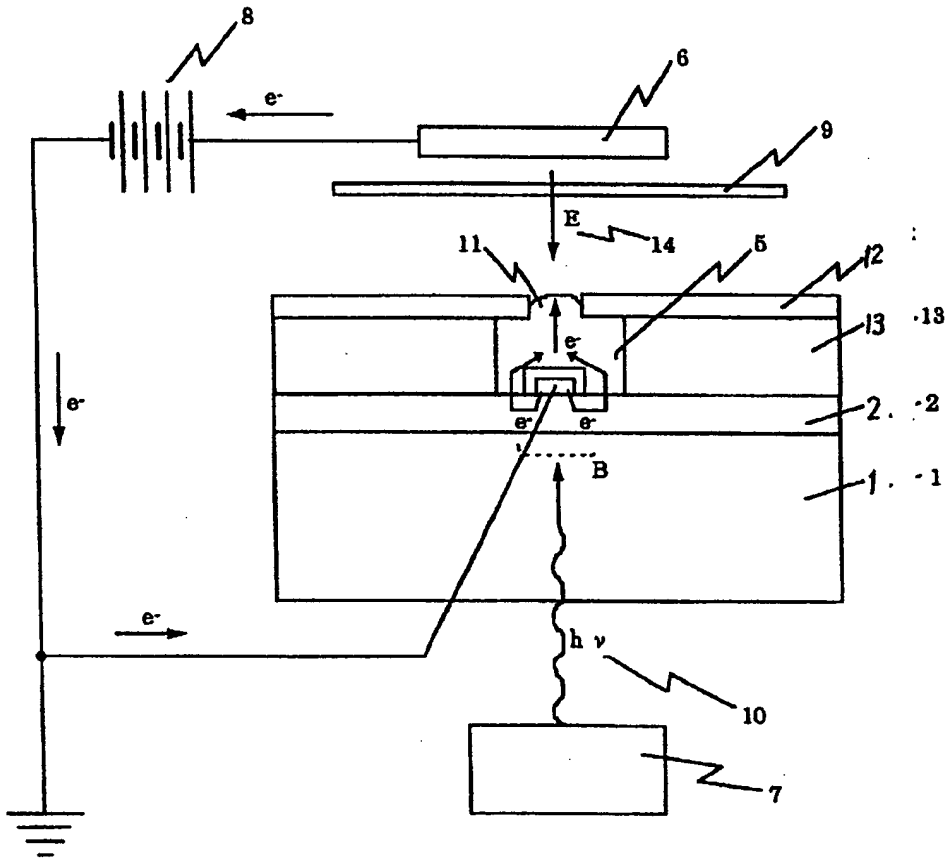


FIG. 9

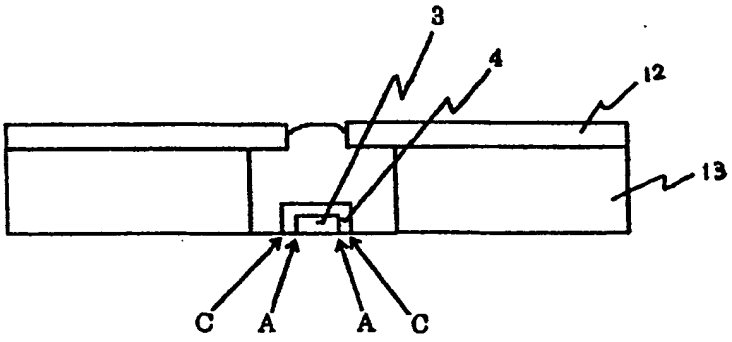


FIG. 10
PRIOR ART